Palestine Polytechnic University
College of

Mechanical Engineering Department
Theory of Machine
First Exam

Instructor: En. Jalal Salaimeh
Date: 10/11/2010
Time: 75 min.

Student Name:
Student Number:
Section: 1

www.vGloop.com/group.php?id=54

Notes: 1) Solve The following 3 problems on the same paper, each on page.
2) Write your name on each page.

Question #	1 (6)	2 (6)	3 (8)	4	5	.....	Total Grade
Grade	6.0	6.0	7.0				19

P1) (6 points)

P1): For the mechanism shown in Fig.1:

a) Describe the motion of each link.
b) Find the number of degree of freedom of the mechanism.

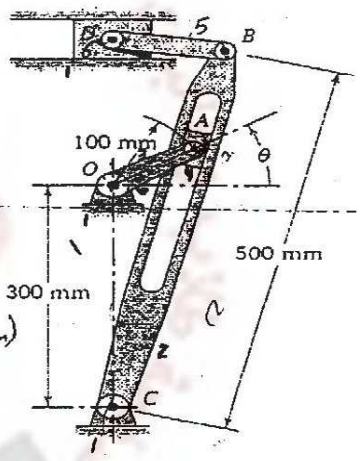

Fig.1

Link # 1 => is a fixed link. 5.0

Link #2 => is rotating about point C

Link #3 => rotates about point O

Link #4 => genral plane motion (rotation and translation)

Link #5 => general plane motion

Link #6 => translation (sliding)

$n = 6$, $J_1 = 7$, $J_2 = 0$

$M = 3(n-1) - 2J_1 - J_2$

$M = 3(5) - 2(7)$

$= 15 - 14$

$= 1$

$\therefore \boxed{M = 1}$

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Student Name: .....
Student Number: .....

P3) (8 points)

At the instant $\theta = 45°$, link DC in Fig. P3 has an angular velocity of $\omega_{DC} = 4$ rad/s and an angular acceleration of $\alpha_{DC} = 2$ rad/s^2. Determine the angular velocity and angular acceleration of rod AB at this instant. The collar at C is pin connected to DC and slides freely along AB.

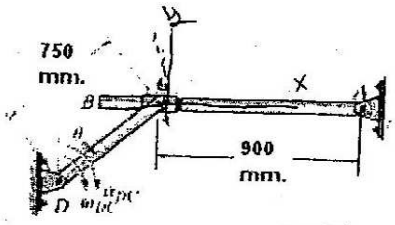


Fig. P3

$V_c = \omega_{DC} \times r_{CD} = -4k \times (.75\cos 45\, i + .75 \sin 45\, j)$

$= 2.12\, j + 2.12\, i$

$V_c = \sqrt{2.12^2 + 2.12^2} = 3$ m/s.

$a_c = \alpha_{DC} \times r_{CD} = -2k \times (.75\cos 45\, i + .75 \sin 45\, j)$

$= -1.06\, j + 1.06\, i + \omega \times (\omega \times r_{AB})$

$a_c = \sqrt{1.06^2 + 1.06^2} = 1.5$

$V_A = V_c + \omega_{CA} \times r_{AC} + V_{rel}$

$V_A = [2.12\, i - 2.12\, j] + \omega_{CA} k \times [.9\, i] + V_{rel}\, i$

$V_A\, i = 2.12\, i - 2.12\, j + .9\, \omega_{CA}\, j + V_{rel}\, i$, $V_A = 0$

$2.12 = V_{rel}$, $.9\, \omega_{CA} = 2.12 \rightarrow \omega_{CA_k} = 2.35$ rad/s

$a_A = a_c + a_{rel} + 2\omega_{CA} \times V_{rel} + \alpha_{CA} \times r_{AC} + \omega_{CA} \times (\omega_{CA} \times r_{AC})$

$0.0 = [1.06\, i - 1.06\, j] + 2(2.35)_k \times 2.12\, i + \alpha_{CA_k} \times [.9\, i] + 2.35_k \times (2.35_k \times (.9)\, i) + a_{rel}\, i$

$= 1.06\, i - 1.06\, j + 9.964\, j + .9\, \alpha_{CA}\, j - 4.97\, i = a_{rel}\, i$

$0 = 8.904\, j + \alpha_{CA}\, .9\, j - 3.91\, i - a_{rel}\, i$

$8.904 = .9\, \alpha$ & $a_{rel} = -3.91$ m/s^2

$\rightarrow \alpha_{CA} = 9.89$ rad/s^2

$\omega_{CA} = \omega_{DA}$

$\alpha_{CA} = \alpha_{BA}$

Student Name: .....
Student Number: .....

6

P2) (8 points)

P2): For the mechanism shown in Fig.2:

a) Determine the type of motion of the mechanism.
b) Draw the linkage in its two extreme positions.
c) Find the transmission angle at the extreme two positions.

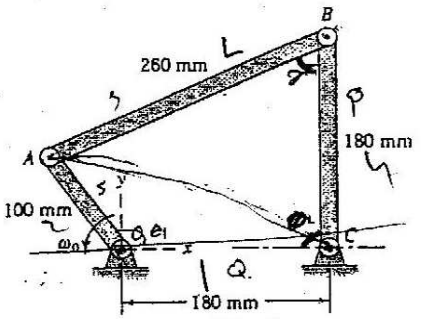


Fig.2

(a) $S + L = 100 + 260 = 360$

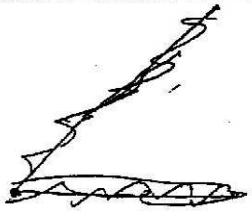
$P + Q = 180 + 180 = 360$

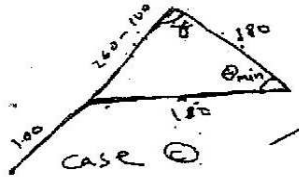
$S + L = P + Q$ (triple rocker)

$3(4-1) - 2(4) - 0$

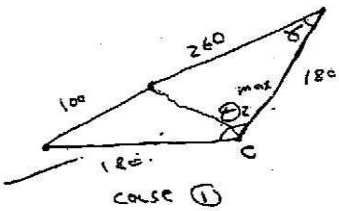
$9 - 8 = 1$

(b)





case ②



case ①

(c) case (1) → when the output angle $\theta_2 = max$

$(0.18)^2 = (0.36)^2 + (0.18)^2 - 2(0.36)(0.18)\cos\gamma$

$\Rightarrow \cos\gamma = \dfrac{(0.18)^2 - (0.36)^2 - (0.18)^2}{-2(0.36)(0.18)} = \dfrac{(0.36)^2}{2(0.36)(0.18)} = \dfrac{0.129}{0.129} = 1$

$\gamma = \cos^{-1}(1) = 0$

ملف الورقة

Palestine Polytechnic University
College of Engineering and Technology
Mechanical Engineering Department

Theory of machine	First Exam
Date:26-11-2007	Time:60 min.

P1): For each of the following mechanisms shown in ***Fig.1:***

a) Describe the ***motion*** of each link.
b) Find the number of ***degree of freedom*** of each mechanism.

P2): Offset crank --slider mechanism shown ***in Fig.2***: with ***R= 60mm, L= 175mm, e=25mm. , rotating C.C.W.***

a) Determine the values of ***input angle θ2*** for ***max. velocity*** of slider.
b) Find the ***time ratio*** of the quick-return mechanism shown

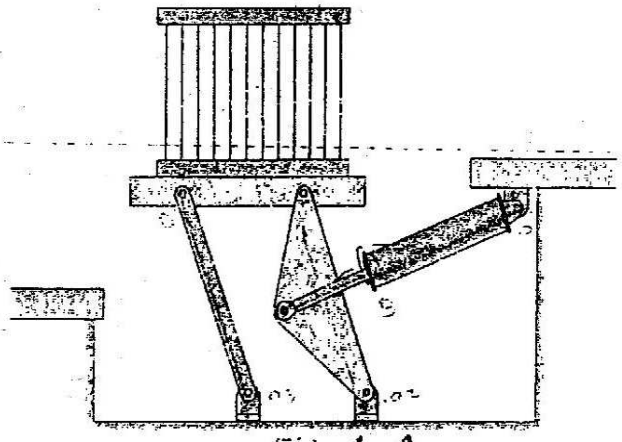


Fig 1.A

The motion of lift platform

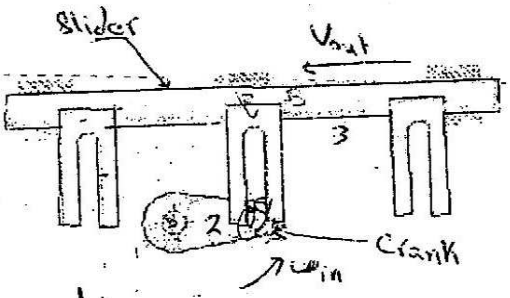


Fig 1:B

linear intermittent motion "Geneva" mechanism

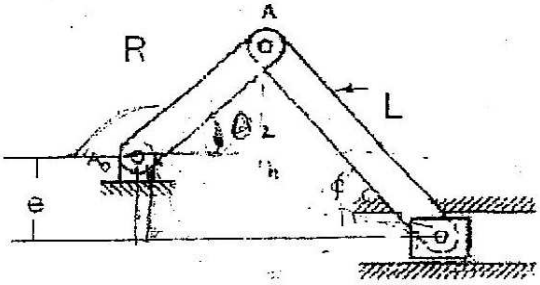
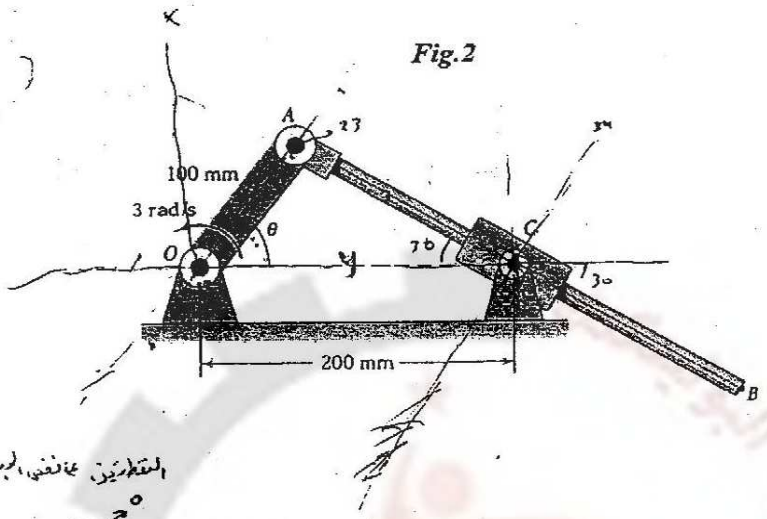


Fig 2

P3): (6 points)

For the mechnism in ***Fig.2***, if ***AB=400mm***. Find the velocity of ***point B*** when $\theta = 60^{\circ}$

Fig.2



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المتغيرين عالشمال اليمين

$$V_A = V_B + V_{rel}^{\circ} + \omega \times r$$

$$3 K \times (100\cos 60\, i + 100\sin 60\, j) = V_B + 3 K \times (400\cos 30\, i - 400\sin 30\, j)$$

$$-300\cos 60\, j + 300\sin 60\, i = V_B + 1200\cos 30\, j + 1200\sin 30\, i$$

$$V_B = (1200\cos 30 - 300\cos 60)\, j + (-1200\sin 30 - 300\sin 60)\, i$$

$$V_B = (1039.2 - 150)\, j + (-600 - 259.8)\, i$$

$$V_B = 889.2\, j - 859\, i$$

$$V_B = \sqrt{(859)^2 + (889.2)^2}$$

$$V_B = 1236.3 \text{ mm/s} = 1.2363 \text{ m/s}$$

(End of Exam)

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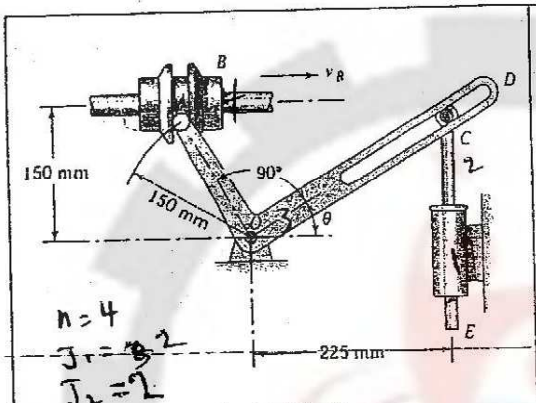
Palestine Polytechnic University
College of Engineering and technology

Department: Mechanical engineering
Course: Theory of Machine
Final Exam

Instructor: En. Jalal Salayma
Date: 11/01/2011
Time: 120 Minutes

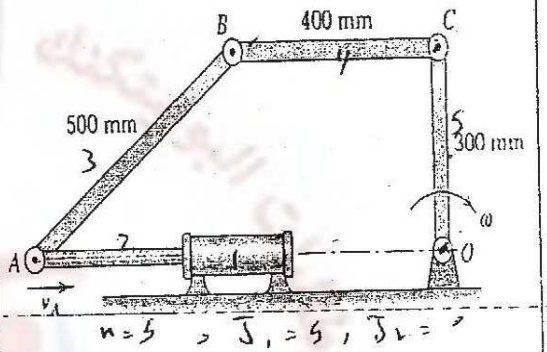
Student Name: صفحة طلاب وطالبات البوليتكنك
Student Number:
Section:.....

P1) (12 points)
For each mechanism ***in fig 1***:
a) Determine the ***degree of freedom*** (Mobility).
b) Describe the ***motion of each link***.



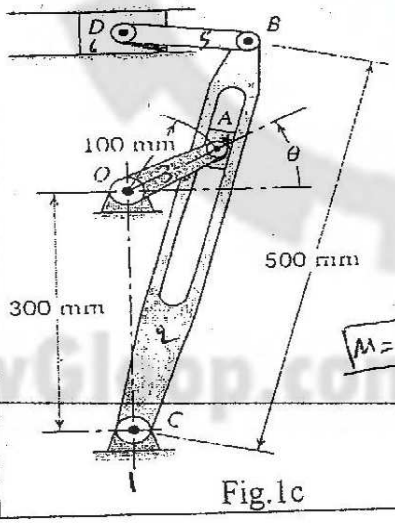
n = 4
J₁ = 3
J₂ = 2
M = 9 − 4 − 2
M = 3

Fig.1a



n = 5 , J₁ = 5 , J₂ = 2
M = 2

Fig.1b



n = 6
J₁ = 7
J₂ = 2
M = 1

Fig.1c

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Palestine Polytechnic University
College of Engineering and Technology
Mechanical Engineering Department

Theory of machine	First Exam
Date:26-11-2007	Time:60 min.

P1): For each of the following mechanisms shown in ***Fig.1:***

a) Describe the ***motion*** of each link.
b) Find the number of ***degree of freedom*** of each mechanism.

P2): Offset crank --slider mechanism shown ***in Fig.2***: with ***R= 60mm, L= 175mm, e=25mm. , rotating C.C.W.***

a) Determine the values of ***input angle θ2*** for ***max. velocity*** of slider.
b) Find the ***time ratio*** of the quick-return mechanism shown.

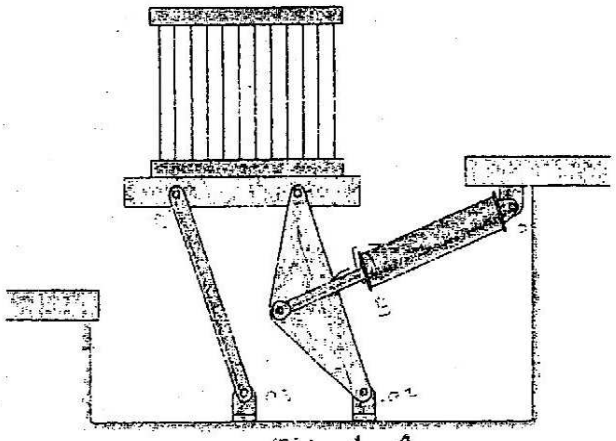


Fig 1.A

the motion of lift platform

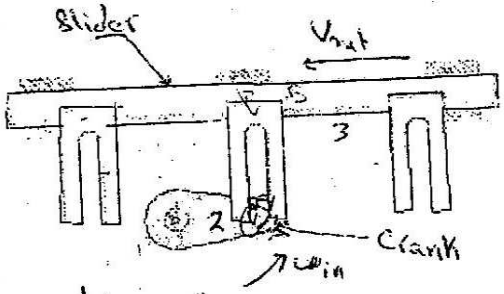


Fig 1:B

linear intermittent motion "Geneva" mechanism

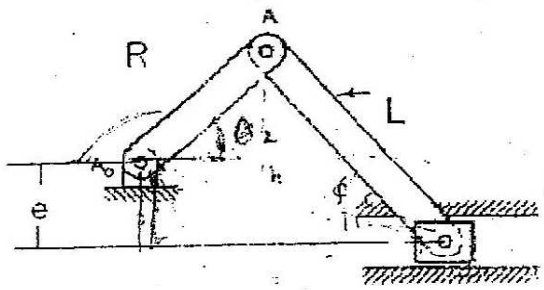


Fig 2

Palestine Polytechnic University

Mechanical Engineering Department

Theory of Machines *First Exam* *Time Limit: 90 min.*

Q1: In a four bar linkage the lengths of links are $s=4$, $l=8$, $q=6$ and $p=7$.

(a) Is this mechanism satisfies Grashof's law? Show how?

(b) Draw the four inversions of such a mechanism, describing the motion of each.

(c) If q is fixed, find the swinging angle of the driven link.

Q2: Shown in figure (1) is a modified scotch yoke mechanism in which the guide of the yoke is a circular arc of radius r and R is the crank radius. Derive an expression for the displacement x of the yoke (link 4) in terms of θ, r, and R. Also express the velocity and acceleration of the same link.

Q3: In the mechanism shown in figure (2), link 2 drives link 3 through a pin at point B. link 2 rotates at a uniform angular velocity ω_2 of 50 rad/s, and the radius of curvature R of the slot in link 3 is *305 mm*. Determine the acceleration A_{B_3} of point B_3 on link 3 and the angular acceleration α_3 for the position shown.

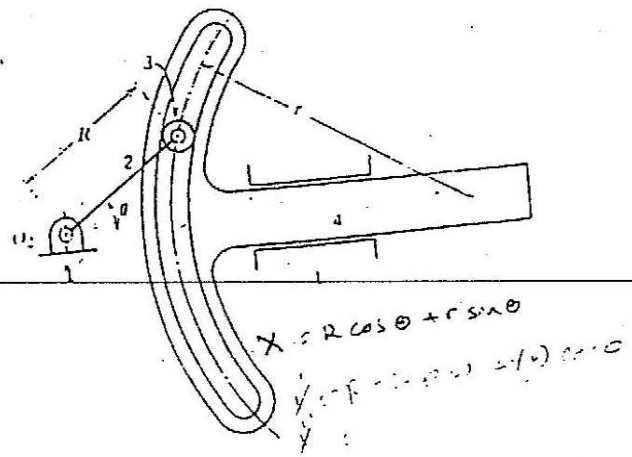


Figure (1)

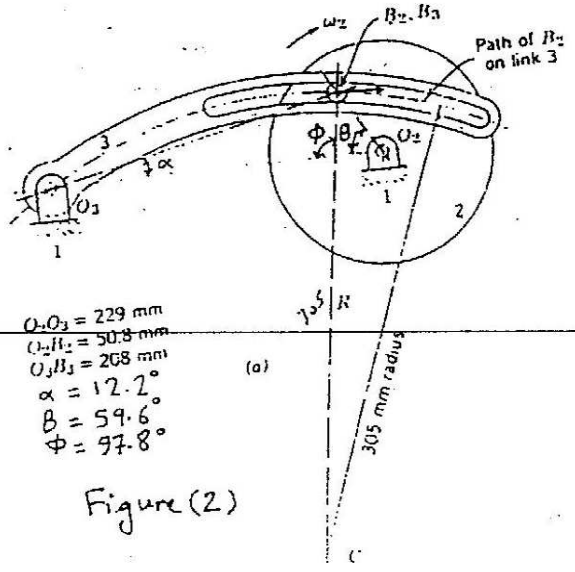


Figure (2)

بسم الله الرحمن الرحيم

POLYTECHNIC-PALESTINE
MECHANICAL ENGINEERING DEPT

Time: 1.5 h.	First exam	Date: 21/12/2000
	Machine Theory	

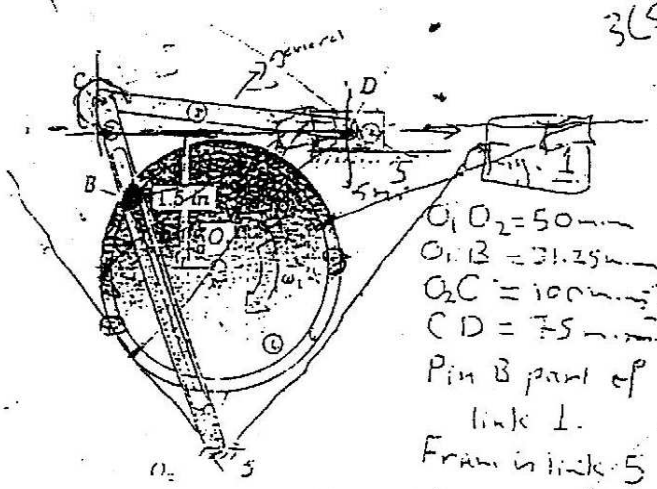
P1: For the mechanism shown in *Figure 1.*:

a) Determine the mobility of this mechanism.
b) Describe the motion of each link.
c) Show the linkage in its limiting positions (corresponding to extreme positions of slider).
d) Find the working to return time ratio (*Q*).
e) Find the stroke of the slider (distance between limiting positions)

P2: For a crank–rocker linkage: If the driver crank length *L1=160m.m.* , Coupler length *L2=200m.m* , And follower length *L3=300m.m.* Find the length of the fixed link *L0* for a minimum transmission angle of *45*. Then find the maximum transmission angle.

P3: Find all the instantaneous centers of the mechanism shown in *Figure 2.*

P4: For the four bar linkage shown in *Figure 3*. Find the acceleration of *A* and *B* and the angular acceleration of links *3* and *4*, Crank *2* has a constant angular velocity of *200rad/s. CCW.*



$O_1O_2 = 50$ m.m
$O_1B = 31.25$ m.m
$O_2C = 100$ m.m
$CD = 75$ m.m
Pin B part of link 1.
Frame is link 5

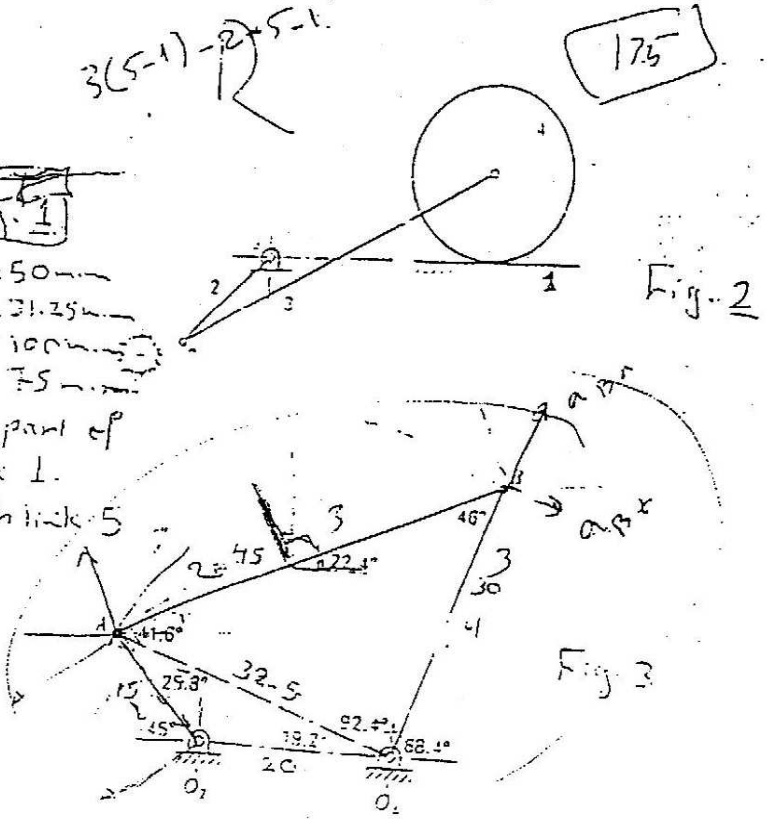


Fig. 2

Fig. 3

$1.5\quad n = 3(4) - 2(5) - 1$

$m = 12 - 10 - 1$

$n = 5$ $\boxed{m = 1}$

$J_1 = 5$

$J_2 = 1$

$m = 3*4 - 2*5 - 1$

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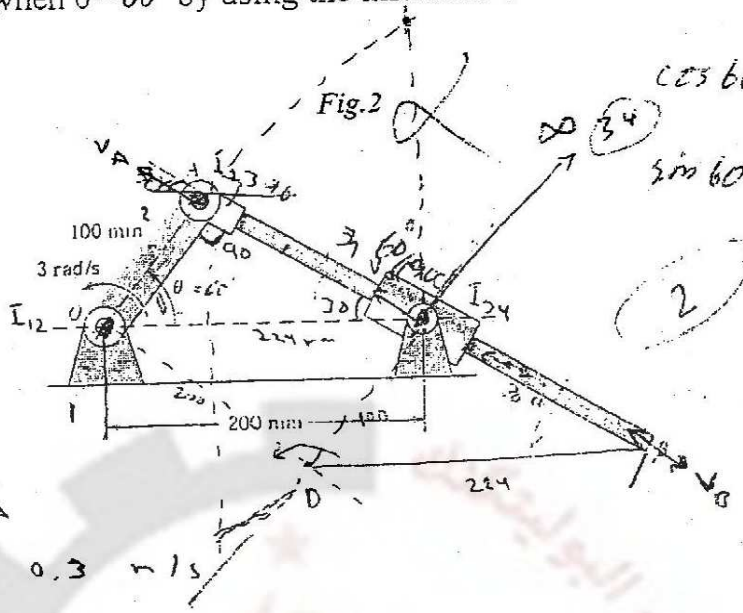
P3): (4 points)

For the mechnism in Fig.2, if AB=400mm. Find the velocity of point B when $\theta = 60^{\circ}$ by using the instantaneous center methode.

Fig.2



$\cos 60 = \frac{100}{200} = 0.5$

$\sin 60 = \frac{x}{200} \Rightarrow x = 200 \sin 60$

$= 173.2$

$V_A = \omega_{OA} \times \overline{OA}$

$= 3 \times 0.1 = 0.3 \ m/s$

$V_C = \omega_D \times 0.1$

$V_C = \omega_{OC} \times \overline{OC} = 3 \times 0.244 = 0.732 \ m/s$

$V_C = \omega_D \times 0.1 \rightarrow \omega_D = \frac{0.732}{0.1} = 7.32 \ rad/s$

$V_B = \omega_D \times 0.224 = 7.32 \times 0.224 = 1.64 \ m/s$

(End of Exam)

Student Name: .....
Student Number: .....

P2) (8 points)

P2): For the mechanism shown in Fig.2:

a) **Determine the type of motion of the mechanism.**
b) **Draw the linkage in its two extreme positions.**
c) **Find the transmission angle at the extreme two positions.**

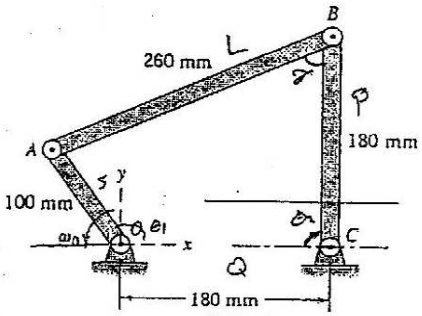


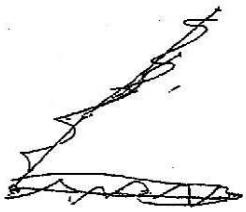
Fig.2

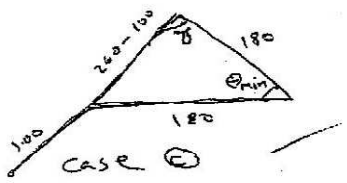
(a) $S + L = 100 + 260 = 360$

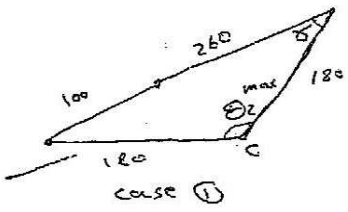
$P + Q = 180 + 180 = 360$

$S + L = P + Q$ (triple rocker)

(b)







(c) case (1) → when the output angle $\theta_2 = max$

$(0.18)^2 = (0.36)^2 + (0.18)^2 - 2(0.36)(0.18)\cos\gamma$

$\Rightarrow \cos\gamma = \dfrac{(0.18)^2 - (0.36)^2 - (0.18)^2}{-2(0.36)(0.18)} = \dfrac{(0.36)^2}{2(0.36)(0.18)} = \dfrac{0.129}{0.129} = 1$

$\gamma = \cos^{-1}(1) = 0$

Student Name: .....
Student Number: .....

P3) (~~6~~ 5 points) (7)

For the blade saw mechanism in Fig.3. find the velocity and acceleration of the blade (The same as point A) when θ = 60o if the crank rotates by constant angular velocity of 100 rpm.

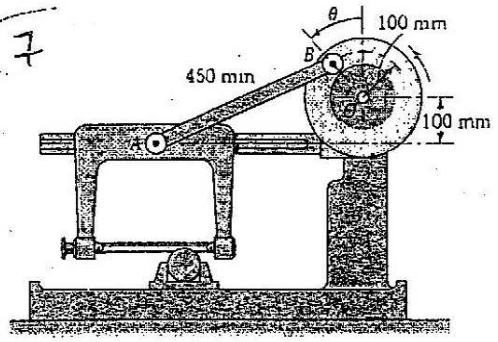
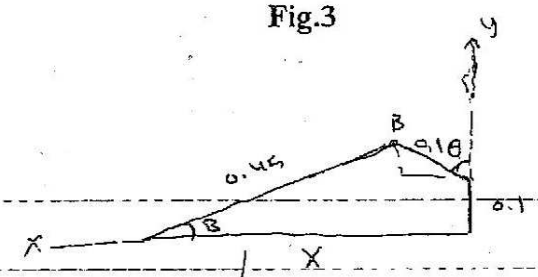


Fig.3

$\dot{\theta} = W = 100 * \frac{2\pi}{60}$

$= 10.47 \text{ rad/s}$



$X = 0.45 \cos\beta + 0.1 \sin\theta$

$\dot{X} = -0.45 \sin\beta \cdot \dot{\beta} + 0.1 \cos\theta \cdot \dot{\theta}$

$\ddot{X} = -0.45 \sin\beta \cdot \ddot{\beta} - 0.45 \cos\beta \cdot \dot{\beta}^2 + 0.1 \cos\theta \cdot \ddot{\theta} - 0.1 \sin\theta \cdot \dot{\theta}^2$

$\ddot{X} = -0.45 \sin\beta \cdot \ddot{\beta} - 0.45 \cos\beta \cdot \dot{\beta}^2 - 0.1 \sin\theta \cdot \dot{\theta}$

$\sin\beta = 0.1 + 0.1 \cos\theta$

$= 0.05$ when $\theta = 60°$

$\beta = 27.1°$

$\sin\beta = 0.1 + 0.1 \cos\theta$

$\cos\beta \cdot \dot{\beta} = 0.1 \cos\theta \cdot \dot{\theta}$

$\dot{\beta} = \frac{0.1 \cos\theta \cdot \dot{\theta}}{\cos\beta} = 10.34$

$\ddot{X} = -0.45 \sin(27.1)\left(\frac{0.1 \cos 60 * 10.47}{\cos 27.1}\right) + 0.1 \cos 60 * 10.47$

$\cos\beta \cdot \ddot{\beta} - \sin\beta \cdot \dot{\beta}^2 = 0.1 \cos\theta \cdot \ddot{\theta} - 0.1 \sin\theta \cdot \dot{\theta}^2$

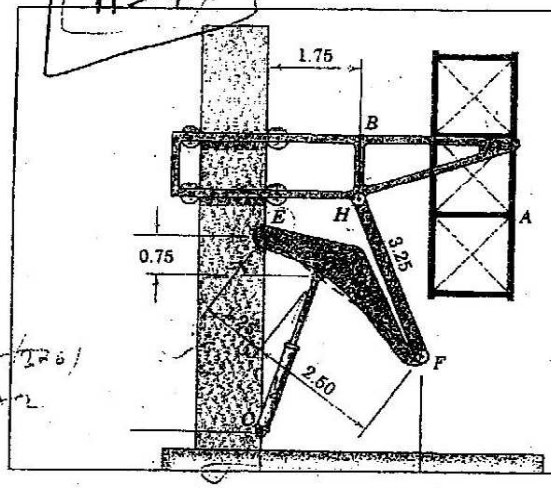
$\Rightarrow \ddot{\beta} = \frac{\sin\beta \cdot \dot{\beta}^2 - 0.1 \sin\theta \cdot \dot{\theta}^2}{\cos\beta}$

$\ddot{X} = -(6.45) * (0.99) * (10.34) + 0.52$

$\ddot{X} = -4.08 \text{ m/s}$

$\therefore V_A = \dot{X} = 4.08 \text{ m/s}$ ↓ جلف الورقة

(End of Exam)

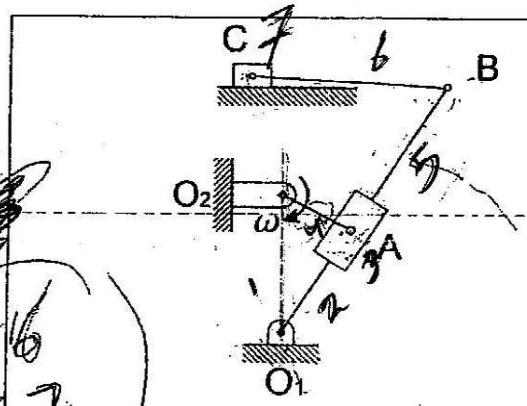


N = 6

P₁ = 7

P₂ = 1

F = 3(4) − 2(5) − 1 = 12 − 10 − 1 = 1



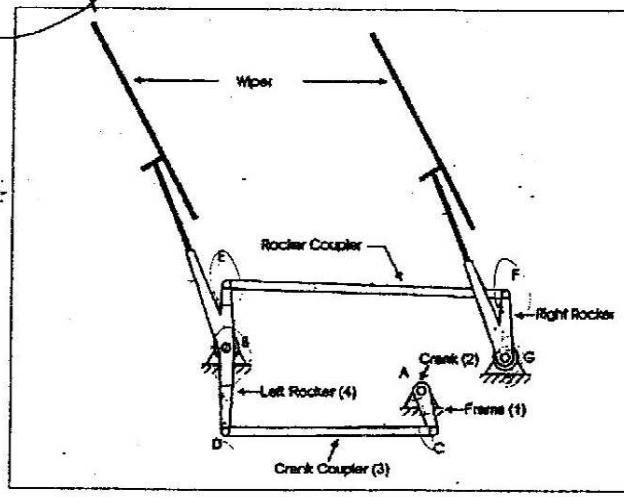
N = 6

P₁ = 7

P₂ = 0

F = 3(5) − 2(7) − 1 = 15 − 14 = 1

15 − 12 = 3



N = 6

P₁ = 7

P₂ = 0

F = 3(5) − 14 − 0 = 15 − 14 = 1